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(71) Applicant *(for all designated States except US)*: **PANTEX SUD S.R.L.** [IT/IT]; Via Calamandrei, fraz. Spedalino Asnelli, Agliana (PT) (IT).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **CECCONI, Riccardo** [IT/IT]; Via Michelozzo 24, I-59100 Prato (IT).

(74) Agents: **MANNUCCI, Michele** et al.; Ufficio Tecn. Ing. A. Mannucci S.r.l., Via della Scala, 4, I-50123 Firenze (IT).

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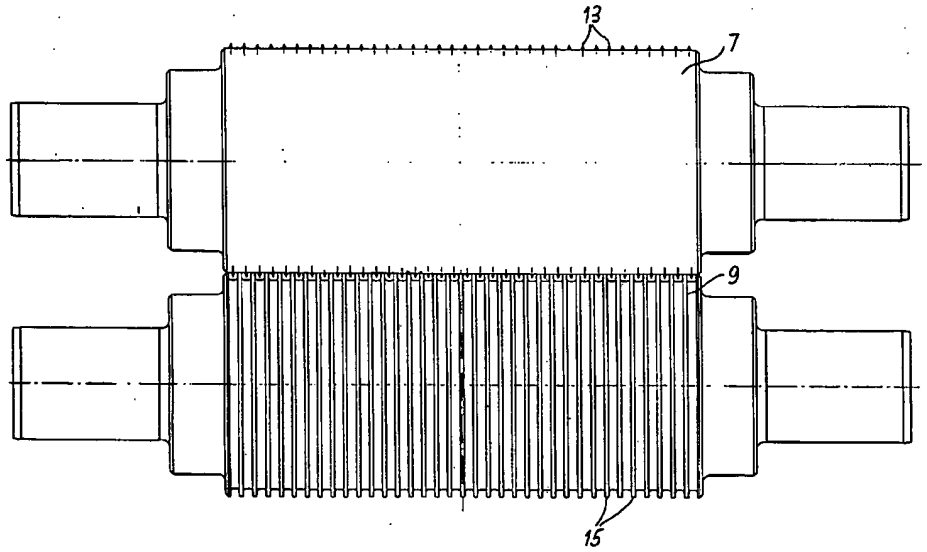
(54) Title: DEVICE AND METHOD FOR PERFORATING WEB-LIKE MATERIALS



(57) Abstract: The device for the perforation of a web-like material (N) comprises a first roller (7) provided with protuberances (13), cooperating with a second roller (9), said first and said second roller being arranged along parallel axes and rotating in opposite directions forming between them a perforation nip (8) through which the web-like material (N) passes. The second roller (9) is provided with a plurality of annular projections (15) arranged in such a way that the protuberances (13) arrange themselves between contiguous annular projections (15). In this way the web-like material is pinched in the perforation nip (8) between the first roller (7) and the annular projections (15) of the second roller.

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Device and method for perforating web-like materials

Description

Technical Field

This invention relates to devices and methods for producing perforated web-like materials such as films, non-woven fabrics or other materials in continuous sheets, destined for use in the production of absorbent articles such as baby diapers and sanitary napkins or in the production of filtering items or other products.

State of the art

Layers of materials in perforated sheets are used in the production of absorbent articles, such as baby diapers and the incontinent, sanitary napkins, absorbent bandages and other products. In diapers and sanitary napkins, for example, the top-sheet, designed to come into contact with the skin of the person wearing the product, is composed of a perforated sheet which permits the passage of the body fluids which the product is designed to absorb. This layer can be composed of a perforated film, a non-woven fabric, a web of fibers, a multilayer structure consisting of films and layers of textile fibers for example, or the like.

Perforation is carried out using various techniques. The technology of interest in reference to this invention envisages the use of a roller or cylinder provided with protuberances or projecting points, which cooperates with a pressure counter-roller.

EP-A-0598970 disclosees a method and a machine for perforating films or other sheet materials, destined for the production of absorbent or filtering products. According to this known technology, the roller provided with protuberances rotates at a surface speed which is greater than the surface speed of the pressure roller so that it tears the sheet material as an effect of plastic deformation.

EP-A-1046479 and EP-A-1048419 disclose devices and methods for perforating plastic or similar films in which a roller provided with needles cooperates with a counter-roller in which there are holes into which the roller needles penetrate. The holes are shaped in a manner complementary to the shape of the needles to cause deformation of the film during perforation.

The problem with these known devices and methods is that the web-like

material to be perforated is crushed when it passes into the nip between the roller and the counter-roller, also because of the limited height of the protuberances. This crushing causes a reduction in the thickness of the web-like material, particularly when this material is a textile material, typically a non-woven fabric. This reduction in thickness constitutes a negative aspect, inasmuch as it reduces the distance which – in the end-product – remains between the outer surface in contact with the user's skin and the first internal layer of the absorbent product, typically a body fluid acquisition and distribution layer.

Objects and summary of the invention

The object of this invention is to provide a device which reduces or eliminates these problems. In particular, the object of the invention is to provide a device which limits or eliminates the reduction in the thickness of the web-like material during perforation.

According to another aspect, an object of this invention is to provide a method for perforating a web-like material which limits or eliminates the problem of crushing and reduction in the thickness of the material itself during perforation.

Substantially, therefore, from a first point of view, the invention envisages a device for perforating a web-like material, comprising a first roller provided with protuberances, cooperating with a second roller, said first and said second roller being arranged along parallel axes and rotating in opposite directions forming between them a perforation nip through which the web-like material passes, characterized in that the second roller is provided with a plurality of annular projections, arranged in such a way that the protuberances of the first roller arrange themselves between contiguous annular projections, that is, in annular grooves defined by contiguous annular projections. In this way, the web-like material is pinched, in the perforation nip between the two rollers, between the first roller and the annular projections, while the protuberances or points with which the first roller is provided penetrate into the material itself and perforate it. In this way the web-like material is perforated without being subject to excessive crushing. In particular, it is not compressed between the protuberances and the counter-roller, that is, the roller provided with annular projections. The thickness of the web-like material is not therefore reduced, except to a modest extent, by the perforation

operation.

Advantageously the protuberances on the first roller are arranged and dimensioned so as not to come into contact with the second roller. For this purpose, corresponding grooves are made between the adjacent annular projections, the width and depth of which grooves are greater than the width and length in the radial direction of the protuberances of the first roller.

Advantageously, the protuberances of the first roller can have a height of between 0.1 and 5 mm, and preferably of between 0.5 and 4 mm and even more preferably between 1 and 3 mm. Their length can therefore be substantially greater compared with the length, typically in the order of a few tenths of a millimeter, of the protuberances of perforator rollers which cooperate with smooth counter-rollers. This also contributes towards not compressing and not crushing, in a substantial manner, the web-like material being subjected to the perforation process.

From a different aspect, the invention concerns a method for perforating a web-like material in which said web-like material is perforated by making a plurality of protuberances borne by a first rotating roller penetrate through it, characterized in that the web-like material is pinched against the first rotating roller adjacently to said protuberances during perforation.

According to an advantageous embodiment of the method in accordance with the invention, it envisages the steps of:

- arranging a second roller rotating around its own axis in the direction opposite to that of the first roller and defining a perforation nip with the first roller;
- providing, on the second rotating roller, a series of annular projections arranged in such a way that the protuberances of the first roller penetrate between adjacent annular projections of the second roller;
- feeding the web-like material through the perforation nip and perforating the web-like material by means of the protuberances on the first roller, pinching said web-like material, during perforation, between the first roller and the annular projections.

In practice it is possible to envisage heating the web-like material, for

example by heating one or other or both the rollers between which it is perforated. Advantageously heating has the effect of causing at least a partial plasticization of the material, for example of the fibers with the lower plasticization temperature present in the mixture of fibers of which the web-like material is composed when the latter is a textile material. Plasticization facilitates perforation and fixation of the deformation which the web-like material undergoes around the perforated zone, which deformation increases the apparent thickness of the material, that is, its three-dimensionality.

Further advantageous features and embodiments of the invention are set forth in the attached dependent claims.

Brief description of the drawings

The invention will be better understood by following the description and the attached drawing which shows a practical, non-limiting embodiment of the invention. More specifically, in the drawing:

Fig. 1 shows a schematic side view of the device;

Fig. 2 shows a portion in side view of the perforator roller provided with protuberances;

Fig. 3 shows a portion in side view of the counter-roller, that is, the roller provided with projections and annular grooves;

Fig. 4 shows a view of the two rollers in the operating position in the feed direction of the web-like material;

Fig. 5 schematically shows examples of shapes and inclinations of the protuberances or needles of the perforator roller; and

Fig. 6 shows an enlarged schematic section of the work zone in the perforation nip between the two rollers.

Detailed description of an embodiment of the invention

Fig. 1 schematically shows a system for perforating a web-like material N, a non-woven fabric for example. The web-like material N is fed, through a pair of entry rollers 3, into a perforating unit 5, comprising a pair of rollers 7, 9 rotating in opposite directions and defining a perforation nip 8. A further pair of rollers 11 is arranged at the exit of the perforation nip 8. One or both the pairs of rollers 3, 11 can be motorized to impose on the web-like material N the desired feeding speed

into the nip 8 and/or the desired speed of exit from the nip.

The roller 7 is provided with protuberances or points arranged in an appropriate pattern. In the example illustrated (Fig. 2), the protuberances are arranged in helical alignments, that is, inclined with respect to the axis and to the plane orthogonal to the axis of the rollers 7. The inclination of the helix is equal to about 20-25° with respect to a plane orthogonal to the axis of the roller 7. The protuberances, indicated by 13, are also arranged according to annular alignments spaced from one another in the axial direction. The free space between adjacent annular alignments of protuberances 13 is sufficient to permit the penetration, between them, of corresponding annular ribs or projections 15 with which the roller 9 is fitted. In practice, the thickness of each annular projection 15 in the axial direction is equal to or less than the free distance between contiguous annular alignments of protuberances 13. The height, that is the extension in the radial direction, of the protuberances 13 can also be considerable, typically from 0.1 to 3 mm, that is up to one order of magnitude greater than the length of the protuberances normally used in perforation devices of the prior art. The height, that is the extension in the radial direction, of the annular projections 15 is greater than the height of the protuberances 13. The distance between the rollers 7 and 9 is such that the annular projections 15 press against the lateral surface of the roller 7 in the free zone between consecutive annular alignments of protuberances 13.

With this arrangement, when the web-like material N passes into the nip 8 between the rollers 7 and 9 it is pinched by the annular projections 15 against the cylindrical surface of the roller 7, while the protuberances 13 arranged between contiguous projections 15 pierce the web-like material N between pinching points defined by the contiguous projections 15. The pinching of the material between projections 15 and the cylindrical surface of the roller 7 puts the web-like material N in tension, facilitating its perforation as an effect of the penetration of the protuberances 13. However, the relatively great distance between the cylindrical surfaces of the rollers 7 and 9 prevents the web-like material N from being crushed excessively during perforation. This maintains its softness and volume, and therefore its three-dimensionality and the draining capacity of said web-like material, in particular when it is composed of a textile layer, such as a layer (made

up of one or more plies) of non-woven fabric. Some of the advantages obtainable using a non-woven fabric are also found with the use of a web of non-consolidated fibers, or with a plastic film.

The protuberances 13 can have different shapes, some of which are visible in Figs. 5A-5I. In the example illustrated, the protuberances 13 have a cylindrical form, with a pointed tip to facilitate perforation, and conical and frustoconical shapes. These protuberances can have a radial development, as shown in Figs. 5A, 5B and 5C and in the remaining figures, or can be inclined (with respect to the radial direction) forwards or backwards, that is, in the direction of rotation or counter to the direction of rotation of the roller 7. Figs. 5D-5I show various shapes of protuberances or needles inclined with respect to the radial direction. In this drawing the axis of rotation is parallel to the horizontal side of the sheet observing the figures. The size of the section of the points or protuberances can be variable. For example, in the case of cylindrical protuberances, the base diameter can vary from 0.2 to 3 mm. Similarly, in the case of conical or frustoconical protuberances, the base diameter can vary from 0.2 to 3 mm, while the ratio between the smaller base and larger base in frustoconical protuberances can vary between 0.99 and 0.1. The values shown must be considered indicative and not binding.

Depending on the shape, inclination and dimensions of the protuberances 13, these can be made by chemical working or mechanical machining starting from a solid roller. Preferably, however, in consideration of their shape and size, these protuberances will be made in the form of points which are inserted and immobilized in holes made in the body of the roller 7. For example, as shown in the drawing, they can be made from rods whose proximal ends, fixed in the roller 7, are threaded and engage in corresponding threaded holes in the surface of the roller.

Fig. 6 shows the effect of the perforation obtained with the pair of rollers 7 and 9. The web-like material N held by the adjacent annular projections 15 is perforated by the protuberances 13 which may also cause a slight deformation in it that makes part of the material rise from the plane it normally lies on, increasing the apparent thickness of the material itself. The deformation of the material is fixed by means of the heating of the rollers 7 and 9. This is because one or other or both

these rollers can be maintained at a temperature, which varies for example between 20 and 200°C and preferably between 100 and 160°C, at which plasticization of the web-like material or of at least a part or of a component is obtained thereof. For example, the web-like material N can be formed by bi-component fibers or contain a percentage of bi-component fibers, the outer part of which has a relatively low plasticization temperature which is lower than the plasticization temperature of the core and/or of the remaining fibers.

In short, the result of the method of perforation by means of the device described is a web-like material N which maintains its original thickness, as it is not crushed in the perforation nip 8, while its apparent thickness can be found to be increased by the permanent plastic deformation caused by the perforation.

Rollers 7 and 9 can be made to rotate at the same surface speed or at different surface speeds. In this latter case, it is preferable for the surface speed of the roller 7 provided with the protuberances 13 to be greater than the surface speed of the roller 9 provided with the annular projections 15. The speed difference can advantageously be in the order of 1-50% and preferably in the order of 2-30% or 5-20%, though these values must not be deemed limiting.

It is understood that the drawing only shows a practical non-limiting embodiment of the invention which can vary in its forms and arrangements, without moreover departing from the scope of the basic concept of the invention. The sole purpose of the presence of any reference numbers in the attached claims is to facilitate reading in the light of the preceding description and of the attached drawings and does not limit the scope of protection in any way.

Claims

1. A device for perforating a web-like material (N), comprising a first roller (7) provided with protuberances (13), cooperating with a second roller (9), said first and said second roller being arranged along parallel axes and rotating in opposite directions forming between them a perforation nip (8) through which the web-like material (N) passes, characterized in that said second roller (9) is provided with a plurality of annular projections (15) arranged in such a way that said protuberances (13) arrange themselves between contiguous annular projections (15), the web-like material being pinched in the perforation nip (8) between said first roller (7) and said annular projections (15).

2. Device as in claim 1, characterized in that said protuberances (13) are arranged and dimensioned so as not to come into contact with the second roller (9).

3. Device as in claim 1 or 2, characterized in that the height of said annular projections (15) is greater than the radial extension of said protuberances (13).

4. Device as in claim 1 or 2 or 3, characterized in that said protuberances are arranged in alignments which are inclined with respect to the axis of the first roller and in alignments orthogonal to the axis of said first roller (7).

5. Device as in one or more of the previous claims, characterized in that said protuberances have a height of between 0.1 and 5 mm, and preferably of between 0.5 and 4 mm and even more preferably between 1 and 3 mm.

6. Device as in one or more of the previous claims, characterized in that at least one of said first and second rollers is heated.

7. A method for perforating a web-like material (N) in which said web-like material is perforated by making a plurality of protuberances (13) borne by a first rotating roller (7) penetrate through it, characterized in that said web-like material is pinched against said first rotating roller (7) adjacently to said protuberances (13) during perforation.

8. Method as in claim 7, characterized by the steps of:

arranging a second roller (9) rotating around its own axis in the direction opposite to that of said first roller (7) and defining a perforation nip (8) with

said first roller;

- providing, on said second rotating roller (9), a series of annular projections (15) arranged in such a way that the protuberances (13) of the first roller (7) penetrate between adjacent annular projections (15) of the second roller (9);
- feeding said web-like material through said perforation nip and perforating said web-like material by means of the protuberances on said first roller, pinching said web-like material, during perforation, between said first roller (7) and said annular projections.

9. Method as in claim 8, characterized in that said protuberances (13) do not touch the second roller (9).

10. Method as in claim 7, 8 or 9, characterized in that said web-like material is heated during perforation.

11. Method as in claim 10, characterized in that said first and/or said second roller is heated.

12. Method as in one or more of the claims 7 to 11, characterized in that said web-like material is a textile material.

13. Method as in claim 12, characterized in that said web-like material is a non-woven fabric.

14. Method as in claim 12 or 13, characterized in that it comprises thermoplastic fibers, and that said web-like material is heated during perforation to a temperature sufficient to cause plasticization of said fibers.

15. Method as in one or more of the claims 7 to 14, characterized in that said web-like material is deformed in a permanent manner around perforations generated by said protuberances, to increase the apparent thickness of the material itself.

Fig.1

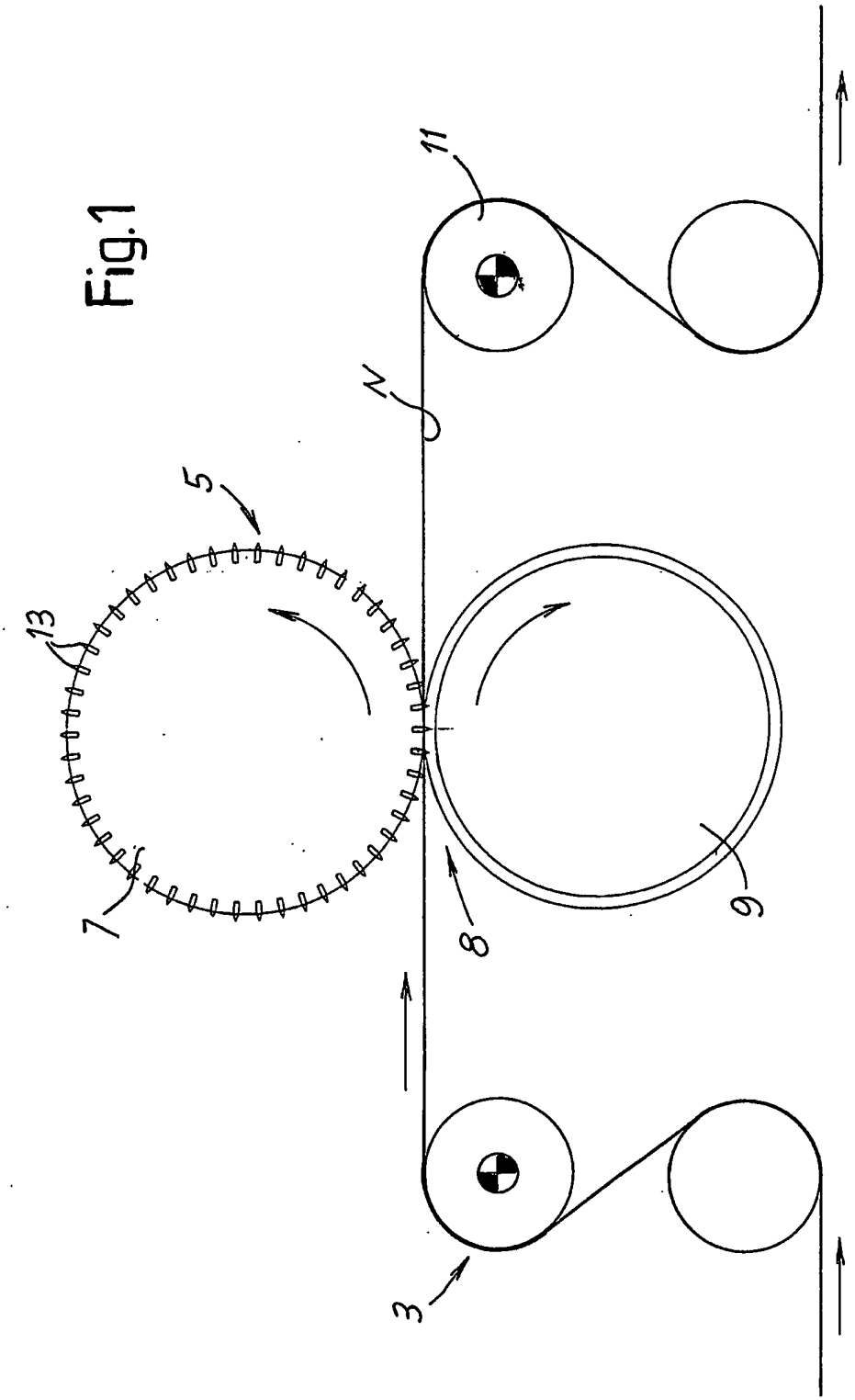


Fig.2

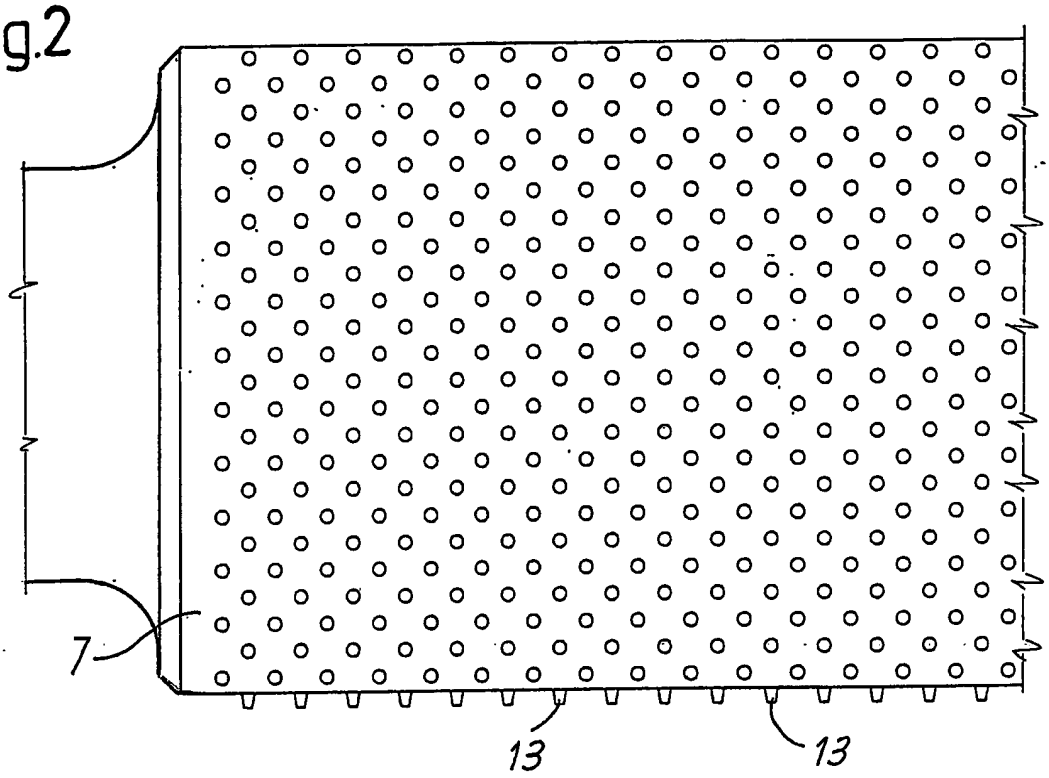
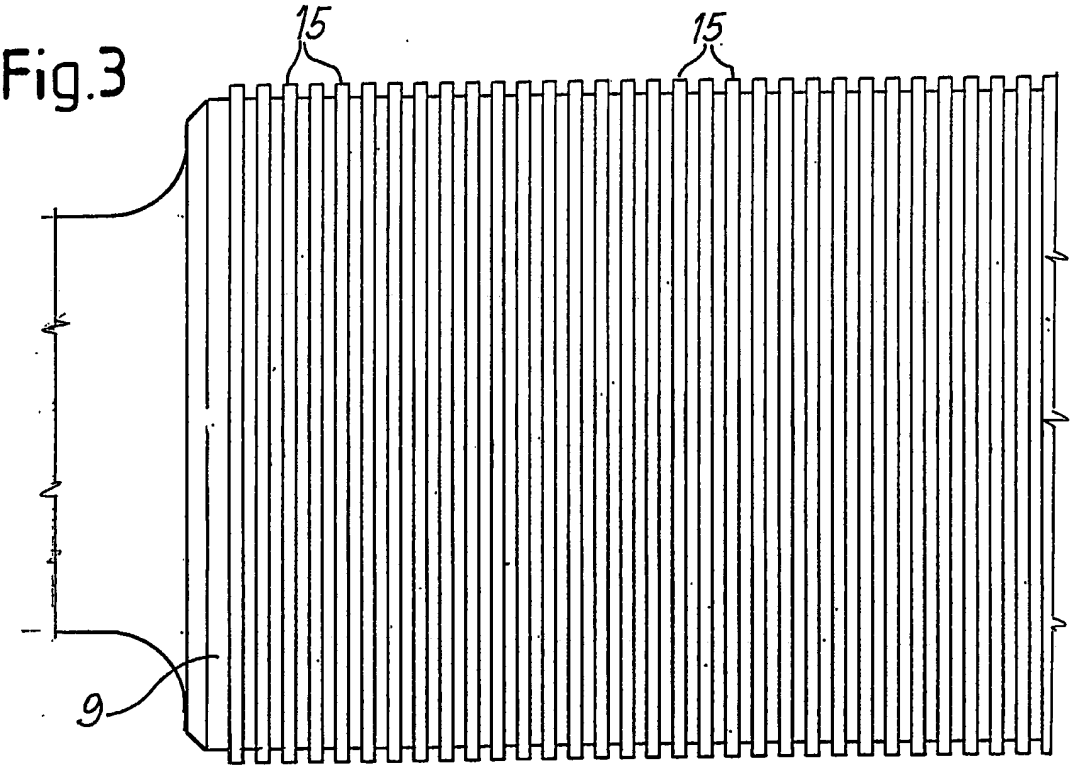


Fig.3



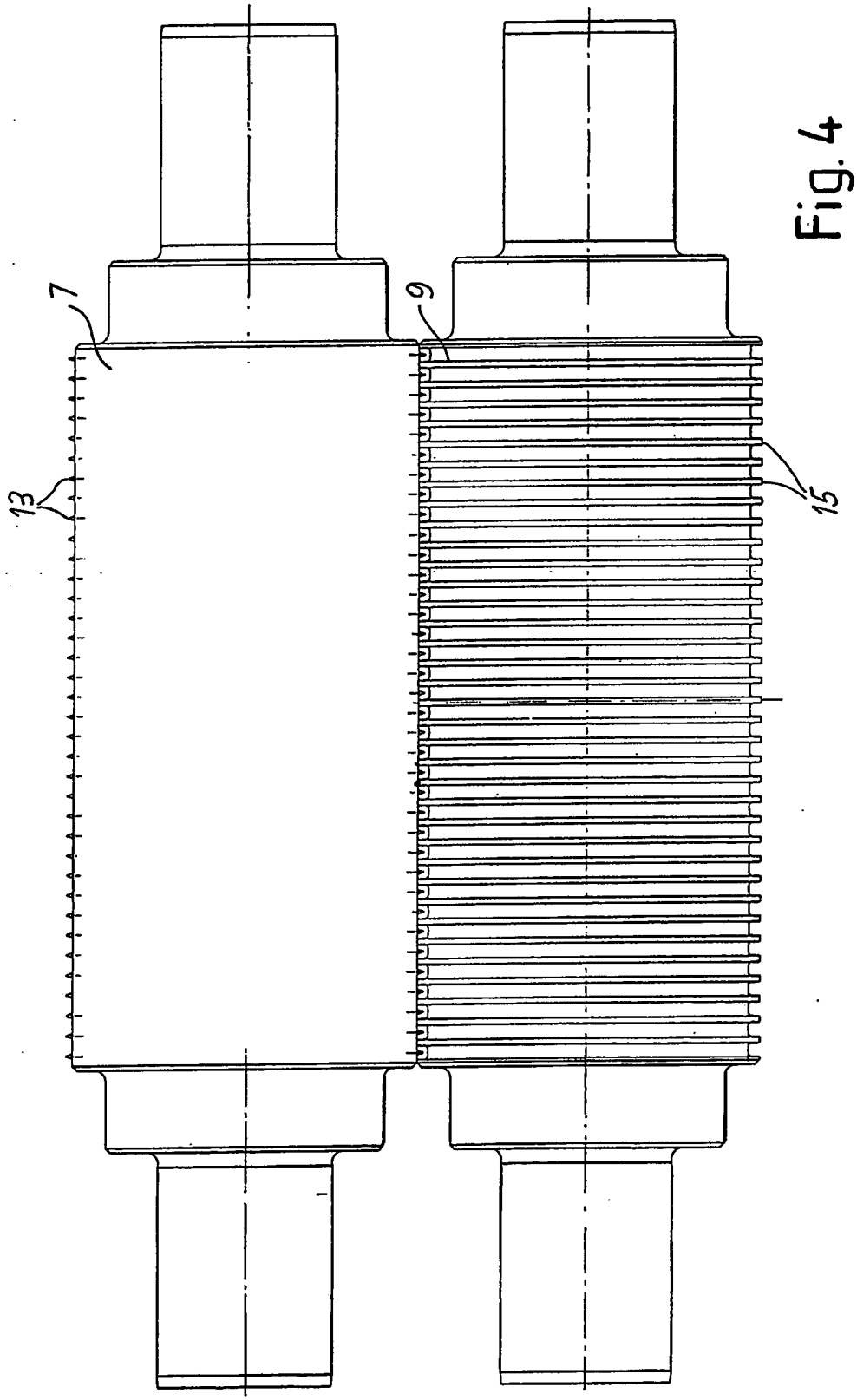


Fig. 4

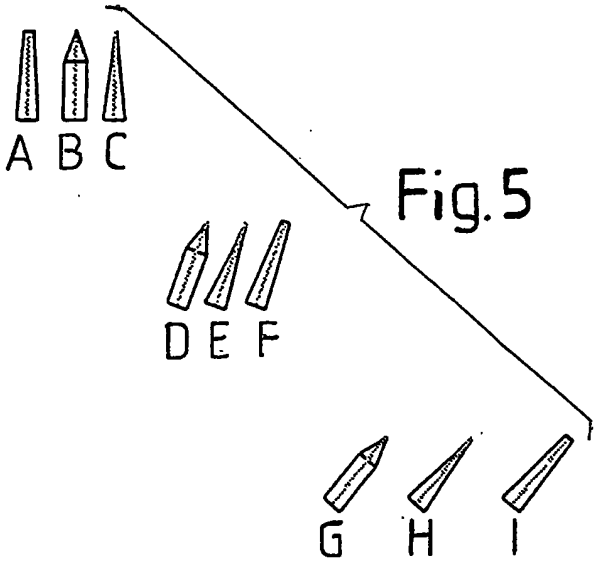


Fig.5

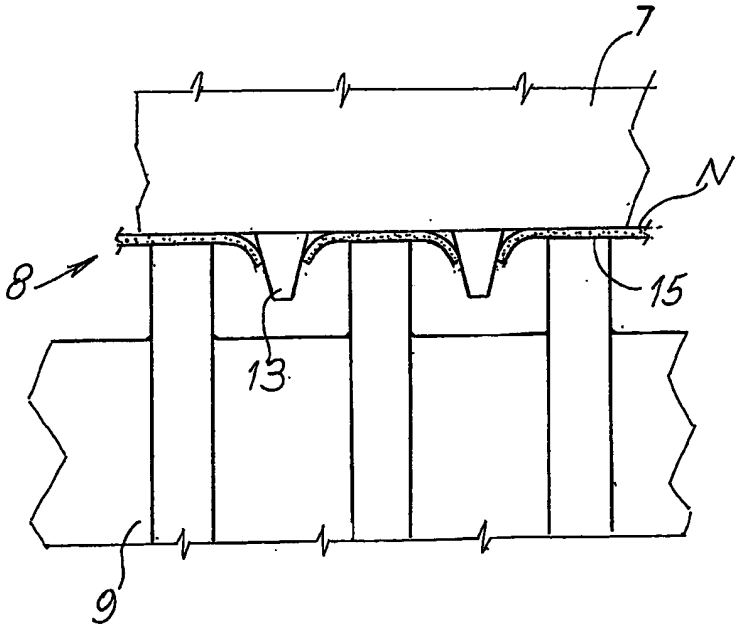


Fig.6

INTERNATIONAL SEARCH REPORT

Internati Application No
PCT/11 03/00496

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B26F1/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B26F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 682 028 A (CLAYTON WILLIAM J ET AL) 8 August 1972 (1972-08-08) the whole document	1-3,5, 7-9,15
X	US 3 546 742 A (KUGLER EMANUEL) 15 December 1970 (1970-12-15) the whole document	1-11,15
Y		12-14
Y	DE 22 04 855 A (JACOB GEB LORBEER HANNELORE) 9 August 1973 (1973-08-09) page 1, paragraphs 1,2; claim 1	12-14
X	CH 451 489 A (VINORA AG) 15 May 1968 (1968-05-15) the whole document	1-5,7-9, 15
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search	Date of mailing of the international search report
23 March 2004	31/03/2004

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Canelas, R.F.

INTERNATIONAL SEARCH REPORT

Internati Application No
PCT/IT 03/00496

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 151 077 A (COLE JR WILLIAM R ET AL) 29 September 1992 (1992-09-29) column 3, line 1 -column 5, line 47; figures 1-5,8	1-5,7-9, 15
X	US 4 635 316 A (TOWNE CLINTON G ET AL) 13 January 1987 (1987-01-13) the whole document	1-3,5, 7-9,15
X	US 4 653 363 A (LANG AAGE) 31 March 1987 (1987-03-31) the whole document	1-5,7, 12,13
X	US 94 333 A (NESMITH) 31 August 1868 (1868-08-31) the whole document	1-5,7-9, 15
X	US 2 748 863 A (BENTON HAROLD Z) 5 June 1956 (1956-06-05) the whole document	1-3, 5-11,15

INTERNATIONAL SEARCH REPORT

Information on patent family members

Internati Application No
PCT/11 03/00496

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US 3682028	A	08-08-1972	NONE		
US 3546742	A	15-12-1970	NONE		
DE 2204855	A	09-08-1973	DE	2204855 A1	09-08-1973
CH 451489	A	15-05-1968	NONE		
US 5151077	A	29-09-1992	NONE		
US 4635316	A	13-01-1987	EP	0208077 A1	14-01-1987
US 4653363	A	31-03-1987	NONE		
US 94333	A		NONE		
US 2748863	A	05-06-1956	NONE		